Literature-based Expedient Criterion for Assessing the Impact Strength of Switzerland's Rockfall Protection Embankment Park

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INTRODUCTION

Rockfall protection embankments are used for protecting elements at risk against events with energies up to 150 MJ. In some countries of the Alpine arch (France, Switzerland, Italy) large structure parks exists, mainly with public ownership. Such structure parks are heterogeneous in terms of construction date, structure technology, constitutive materials, dimensions, and designed capacity. Besides, design rules with respect to embankment impact strength were proposed only recently.
In such a context, questions concerning the efficiency of existing RPEs may rise for instance when dealing with risk management as for instance revising natural risk prevention plans. This article introduces an expedient criterion for assessing the impact strength of rockfall protection embankments and applies it to protective structures built in Switzerland. The criterion is based on data from real-scale experiments available in the literature and conducted by different research teams (see references in Lambert and Bourrier, 2013). It aims at helping public authorities in assessing their park.

EXPEDIENT CRITERION FOR IMPACT STRENGHT ASSESSMENT

The criterion was developed with the aim of finding a simple relation between the downhill face displacement and the block kinetic energy. The downhill displacement is deemed relevant as it is directly related to the post-impact embankment stability. The proposed criterion considers that the embankment is no longer stable if the downhill displacement exceeds 25% of its width. Comparison with more than 20 impact experiments, conducted at the real scale on various structures, showed that the impact strength is verified if:

$$C_{25} = \frac{KE}{250 * A} < 1$$

where KE is the block kinetic energy (kJ), A is the structure cross section area along the vertical axis calculated from the ditch elevation (m²). The subscript 25 in C_{25} refers to the maximum allowable downhill deformation with respect to the structure width (here, 25%).
Considering the experimental conditions, this criterion is particularly valid when:
- the embankment is reinforced;
- the embankment height and mid-height width range between 3-4.2 m and the 3-4.3 m resp.;
- the block has a 30° downward incident trajectory;
- the impact point is located at least ¼ of the structure height.

APPLICATION TO SWSS EMBANKMENTS

More than 250 rockfall protection embankments exist in Switzerland among which 53 less than 20 years old are sufficiently documented to be considered in this study. These are mainly made of compacted soil, with a rockery facing at the uphill slope, with length and height ranging between 15 and 700 m and 1.5 and 13 m, respectively. The reference block considered for their design had a weight and a kinetic energy in very wide ranges: 15 to 1600 kN and 160 kJ to 50 MJ, respectively.
As almost all of the 53 embankments are non-reinforced structures it was decided to divide the acceptable limit of C_{25} by 2, based on results from the literature. **Fig. 1** shows that the criterion is fulfilled for the majority of the structures. On the opposite, this criterion draws the attention on about 20% of the structures for which complementary analysis could be conducted to assess their impact strength based on deeper investigations and calculations.

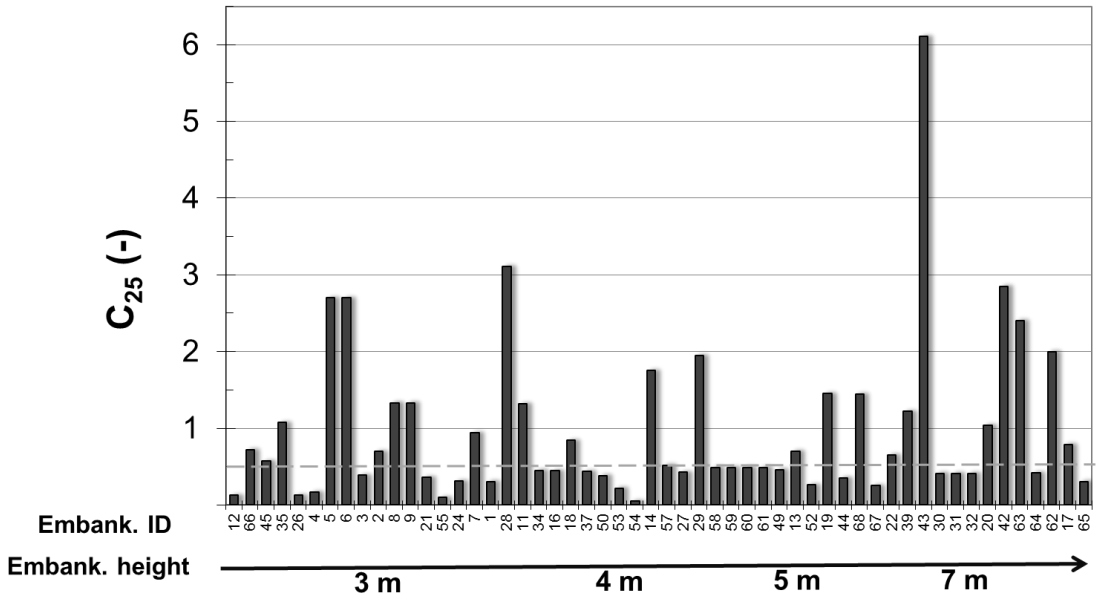

Fig 1. Embankment Swiss park evaluation (limit value of 0.5, accounting for the structures type)

CONCLUSIONS

An expedient criterion has been developed based on real-scale impact tests data and applied to rockfall protection embankments of Switzerland. This criterion is voluntarily kept simple to be applied to a wide variety of structures, even if not well documented. It draws the attention of owners to potentially inefficient structures in resisting the impact, and thus in stopping the block.

REFERENCES

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